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U. S. DEPARTMENT OF AGRICULTURE

Evaluation of SHIPPING CONTAINERS for Western Lettuce

Marketing Research Report No. 248

AGRICULTURAL MARKETING SERVICE
MARKETING RESEARCH DIVISION
UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE AND ACKNOWLEDGMENTS

This is one of a group of reports on studies to develop cheaper and improved shipping containers and methods of shipping agricultural products. It is a part of a broad program of research aimed at improving market efficiency and expanding markets for farm products. Adoption of a standard lettuce container, one of the goals of this study, should help eliminate some causes of confusion in the industry and reduce costs in marketing lettuce.

Earlier reports directly related to this one are "Reduction of Loss, Damage, and Transportation Costs in Package-Iced Shipments of Lettuce and Carrots" (U. S. Department of Agriculture mimeograph, June 1953) which makes a comparative evaluation of the conventional LA (Los Angeles) crate and the new WGA (Western Growers Association) crate for the shipment of lettuce; and "Packing and Shipping Lettuce in Fiberboard Cartons and Wooden Crates" (Marketing Research Report 86, April 1955) which compares crates and fiberboard boxes.

8 Data for this report were gathered by the Western Growers Association under contract with the Department of Agriculture. Acknowledgment is made to Frank W. Castiglione, executive vice-president, and C. B. Moore, former executive vice-president of Western Growers Association, who directed the research work. Marvin L. Haigler arranged the tests at shipping point, Charles F. Bernhard, Carmine Cavallo, and Arthur D'Ornellas inspected the test shipments at destination.

John C. Winter administered the contract for the Department and Donald R. Stokes developed the plan of research and supervised the analysis of the data and preparation of this report.

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SUMMARY

This research was conducted to evaluate the many new shipping containers which came into the market when lettuce growers shifted to vacuum-cooling and moved their packing operations from the packinghouses to the harvest fields of California and Arizona.

The study indicates that a single standard container properly packed can deliver high quality lettuce with a minimum of bruising. Overpacking of any container, regardless of size or type, results in serious bruising.

The introduction of vacuum-cooling permitted lettuce to be packed without ice, and completely changed container requirements. The abrupt abandonment of the standardized containers used with the ice pack created confusion in lettuce marketing channels. The industry needed a single new standard size container. This study was undertaken to aid in the development of such a container.

Research technicians surveyed lettuce producing areas in 1954 to determine the extent to which various containers were then being used in order to select 3 of them for evaluation. They found 3 new fiberboard boxes in general use, 7 various containers in limited use, and as many more being promoted for experimental trials. No two of the 10 containers in general or limited use had the same dimensions. Eight were designed for 2 dozen heads, one for 2½ dozen, and one for 1½ dozen.

The 3 containers selected for study were the 7300 with a capacity of 2,629 cubic inches, the 7302 with a capacity of 2,733 cubic inches, and the 7303 with a capacity of 3,037 cubic inches. (Container numbers are assigned by the National Container Committee of the railroads.) As might be expected the smallest container--the 7300--usually had a comparatively light pack, the 7302 a light or medium pack, and the 7303 a heavy pack.

The 3 selected containers were inspected upon arrival in the New York markets; each of the containers was observed in a minimum sample of 50 full carlot shipments. To minimize the effect of any one variable and to assure that the commercial shipments inspected were typical, the number of cars from any one shipper was strictly limited. More than 50 different crews packed the lettuce. Also, the cars carrying it to market followed as many different rail routes. Some of the lettuce was from the desert and some from coastal areas. There were great differences in the type of refrigeration provided, method of loading, number of containers in the load, and time in transit.

It was found that as the weight of the pack increased from light and medium to heavy, bruising of the lettuce increased in the containers studied. There was no definitive difference in performance among the three containers but lettuce in the 7302 was bruised slightly less than in the other two containers.

The lack of outstanding differences was interpreted to mean that the 7300 was good for a light pack, the 7302 for a light or medium pack, and the 7303 for a heavy pack.

In an attempt to control some of the known variables, a 9-car controlled experiment was conducted to appraise the same three containers. This showed more conclusively than the commercial shipments that bruising increased with the weight of the pack. The controlled experiment also showed appreciably less bruising in the large (7303) than in the medium (7302) and far less than in the small (7300) container.

Bruising went up as weight increased in relation to space available in the container. This relationship is a measure of tightness of pack--so the tighter the pack the more the bruising.

A study of the relation between tightness of pack and bruising indicated that a weight-space ratio of between 1.40 and 1.50 pounds per 100 cubic inches of container capacity might be best for a single standard container for all weights of lettuce noted in the 166 commercial shipments. The average weight of pack in the commercial shipments was 40.7 pounds. At the midpoint of a ratio of from 1.40 to 1.50 pounds per 100 cubic inches, the 40.7-pound pack would require a container with a capacity of approximately 2,810 cubic inches. This is between the capacities of the 7302 and the 7303 and very close to the 2,866 cubic inches of the new 7306 designated as the standard fiberboard lettuce container by the California and Arizona legislatures in 1957.

The weight-space relationship with an upper limit of 1½ pounds per 100 cubic inches would not result in the least attainable bruising of lettuce because a less tight pack would further reduce the chance of injury. It would assure, however, the optimum economic use of the container space available and probably would avoid the sharp rise in bruising observed when the weights went higher.

EVALUATION OF FIBERBOARD SHIPPING CONTAINERS FOR LETTUCE

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Western Growers Association [1]

NEED FOR STUDY

The nailed wooden Western or Los Angeles crate type 929, generally known as the LA crate, was standard for the shipment of California and Arizona lettuce to distant markets for more than 30 years (fig. 1). Most usual inside dimensions were 13 3/4 by 17 1/2 by 21 3/4 inches. The crate was approximately four-fifths as wide as it was long, and it was admirably adapted to carry the most common size of lettuce grown 30 years ago called the 5-dozen pack. In this crate the lettuce was arranged in 3 layers, each 4 heads wide and 5 heads long.

Crushed ice between the layers of lettuce in the crates and a heavy blanket of top ice over the load of crates in the railroad car or truck were the principal means of removing field heat from the lettuce and maintaining refrigeration en route to terminal markets.

Over the years, introduction of better strains and improved cultural methods increased the size of the lettuce heads. Once almost a rarity, the large 4-dozen pack size gradually overtook the smaller 5-dozen pack size in total volume shipped. The larger lettuce was packed into the same crate in the same 3 layers but instead of a layer 4 heads wide and 5 long, it was 4 wide and 4 long.

An early study indicated that the LA crate was unsatisfactory for the 4-dozen pack. [2] Measurements indicated that the total of the diameters of 4 average size heads in the 4-dozen pack exceeded the width of the crate by 1 1/2 inches. At the same time there was an excess of 2 3/4 inches of interior crate length over the total length of the 4-dozen pack. As a result considerable bruising of the lettuce occurred along the sides of the crate.

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[1] Mr. Black is now a marketing specialist and Mr. Chapogas an agricultural economist in the U. S. Department of Agriculture.

[2] Breakiron, P. L. Reduction of Loss, Damage, and Transportation Costs in Package-Iced Shipments of Lettuce and Carrots. Prod. & Mktg. Admin., U. S. Dept. Agr. 1953.

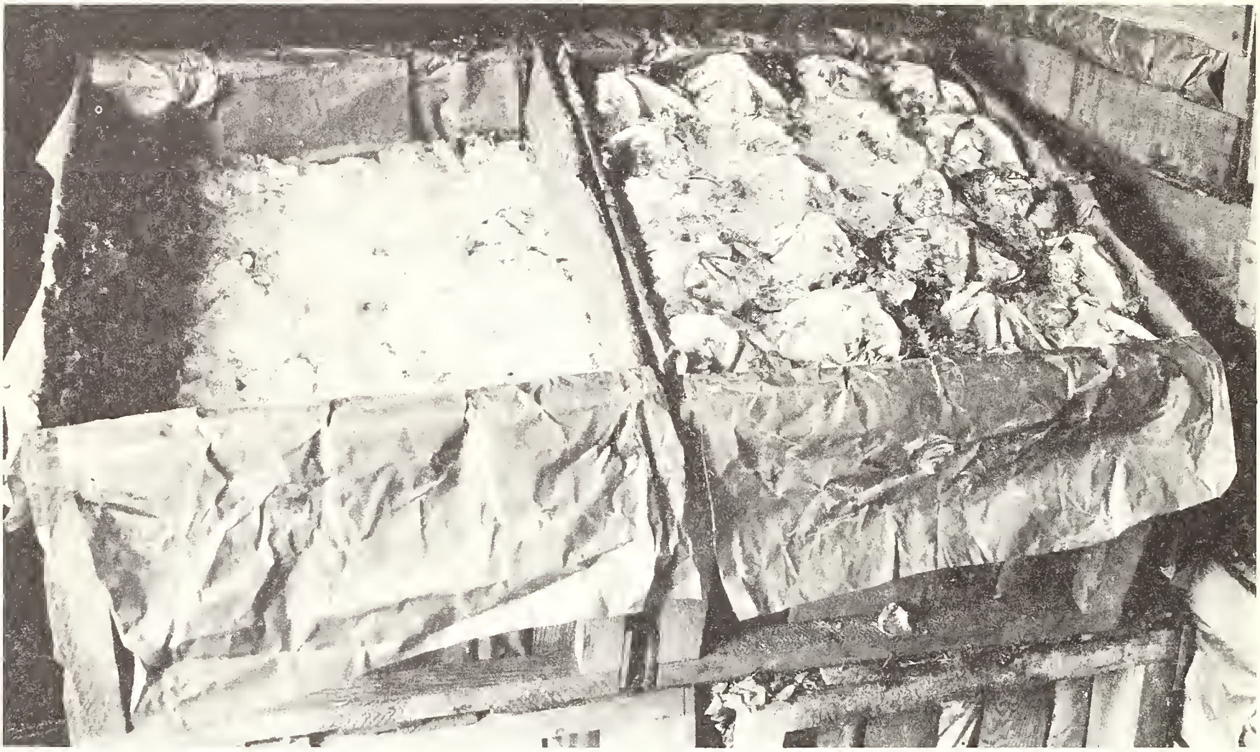

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Figure 1.--The western crate (above) was standard for shipment of lettuce for many years. It carried a 5-dozen pack in 3 layers of 20 heads each. At left the second or middle layer has been covered with ice to remove the field heat and to refrigerate the lettuce. At right, the third layer of lettuce, 5 heads long and 4 wide is packed on top of ice. More ice will be added before the lid is nailed on.

A new nearly square container, known as the WGA crate, was developed. Lettuce bruising and crate breakage were both greatly reduced. Both the LA crate and the WGA crate were designed to carry approximately 30 pounds of crushed ice in addition to the regular lettuce packs.

Although the WGA crate was superior to the old LA crate in many respects, packers were not completely satisfied with it. The industry then introduced the SW crate which gained rapidly in popularity with ice-pack shippers in 1953, particularly in the important Salinas-Watsonville area of California. The depth and width were the same as in the WGA crate but the length was 1 1/4 inches greater.

Shortly after development of the WGA crate, improvements in fiberboard boxes for lettuce made it possible to pack these containers in the field, cool them rapidly to approximately 35 degrees F. in vacuum-cooling plants, and ship them in bunker-iced cars without use of package or top ice (fig. 2). In keeping with the trend to small, more easily handled containers, the new fiberboard boxes were designed for packs of 1½, 2, and 2½ dozen heads of lettuce. The 2-dozen pack was by far the most common. The smaller containers facilitated rapid cooling but presented new problems to shippers and receivers long accustomed to the 4- and 5-dozen packs.

A survey of the packing and shipping costs indicates that substantial savings are realized by dry-packing lettuce in fiberboard boxes in the field as compared with ice-packing lettuce in WGA crates in the packingsheds. [3] The dry pack in fiberboard containers was adopted rapidly, accounting for 40 percent of lettuce shipments in the 1952-53 season, 70 percent in 1953-54, and 95 percent by the end of 1955.

At least 8 fiberboard boxes, a wirebound crate, and a kraft veneer container were tried out by the packers and 10 more containers were on the market in 1954. None was entirely satisfactory and all had different dimensions. Receivers in distant markets were confused and irritated. A wholesaler ordering a 2-dozen pack of lettuce might receive comparatively large heads in comparatively large containers. Or he might receive a 2-dozen pack of appreciably smaller heads packed without slack but in smaller containers.

The Western Growers Association, a trade organization representing vegetable growers and shippers of California and Arizona, sought to determine and establish as a standard the most serviceable container possible, yet one that would be acceptable to growers, packers, distributors, and retailers alike.

The trend away from standardization, and the unknown qualities of the new containers disturbed the entire industry and led to this study to evaluate the new packages.

OBJECTIVES OF STUDY AND PROCEDURE

Objectives of this study were to determine: (1) The effect of various containers on the arrival condition of western head lettuce in eastern markets, and (2) the amount of damage to container in transit.

It was impossible to evaluate thoroughly all of the different shipping containers for western lettuce in use at that time. Therefore, it was arbitrarily decided to evaluate the three containers most generally used in California and Arizona. The 3 selected containers were then evaluated

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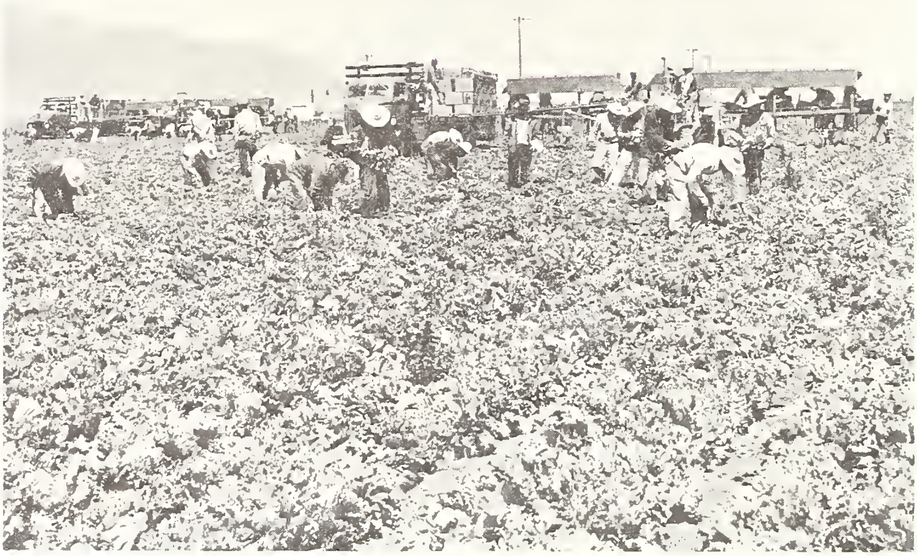
[3] Voegeli, L. J., White, E. F., Masters, B., and Breakiron, P. L. Packing and Shipping Lettuce in Fiberboard Cartons and Wooden Crates. Mktg. Res. Rpt. 86, U. S. Dept. Agr., Apr. 1955.



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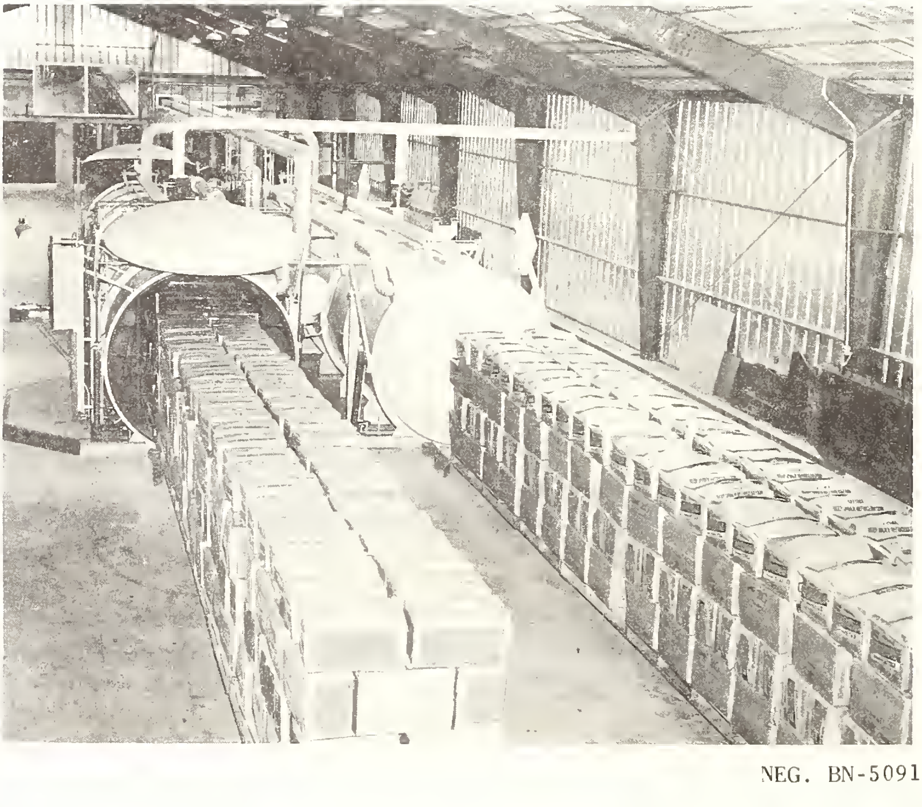

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Figure 2.--Above: Lettuce is being harvested and packed in the field without ice. Below: The packed fiberboard boxes of lettuce are about to enter vacuum-cooling tubes for removal of field heat.

by systematically inspecting a minimum of 50 commercial shipments of each of them. These shipments were selected to represent the effect of various factors such as different shippers, lettuce growing districts, types of lettuce, packing methods, delivering railroads, and seasons of the year.

There was no assurance that any of these 3 containers in most general use was the best being used. Also, it was possible that superior containers would be developed during the progress of the study. Therefore, the second phase of the experiment provided for detailed inspections of 25 additional commercial shipments of lettuce packed in other sizes and types of containers then in use or that might be introduced during the study.

The third phase of the research provided for a series of controlled tests in which the 3 most promising containers would be packed and shipped under controlled conditions. This controlled experiment provided that the 3 containers would each be packed with light, medium, and heavy packs of lettuce and replicated 3 times.

The controlled test was set up for 2 reasons: First, to gather more conclusive evidence as to which of the 3 containers was the best container, and second, to obtain evidence under controlled conditions of the effect of the use of light, medium, and heavy pack on each container. This was necessary because it was known that one of the problems facing the lettuce industry was overpacking the containers, regardless of their type and size.

The field work was conducted by the Western Growers Association under a contract with the Department; this report was prepared in the Department.

Shippers in the principal lettuce producing areas of California and Arizona were interviewed in the spring of 1954 concerning the shipping containers in general use, in limited use, and in experimental use.

Most of the lettuce was being packed in 3 fiberboard boxes. Each of these boxes was selected for observation and evaluation. Five other fiberboard boxes, a wirebound crate, and a kraft veneer container also were in limited or experimental use. Four of these were included in a supplementary 25-carlot evaluation.

Two research groups were formed by the contractor. A western unit moved from district to district in California and Arizona as the season progressed to observe the preparation of the shipments in the packing plants, to note the quality of the lettuce shipped, and to install impact recorders in the test cars. It also sent advance notice of the estimated time of arrival in eastern markets of a sufficient number of shipments for use as a basis for selecting a suitable sample for inspection. An eastern unit inspected and appraised the lettuce shipments after arrival in terminal markets (fig. 3).

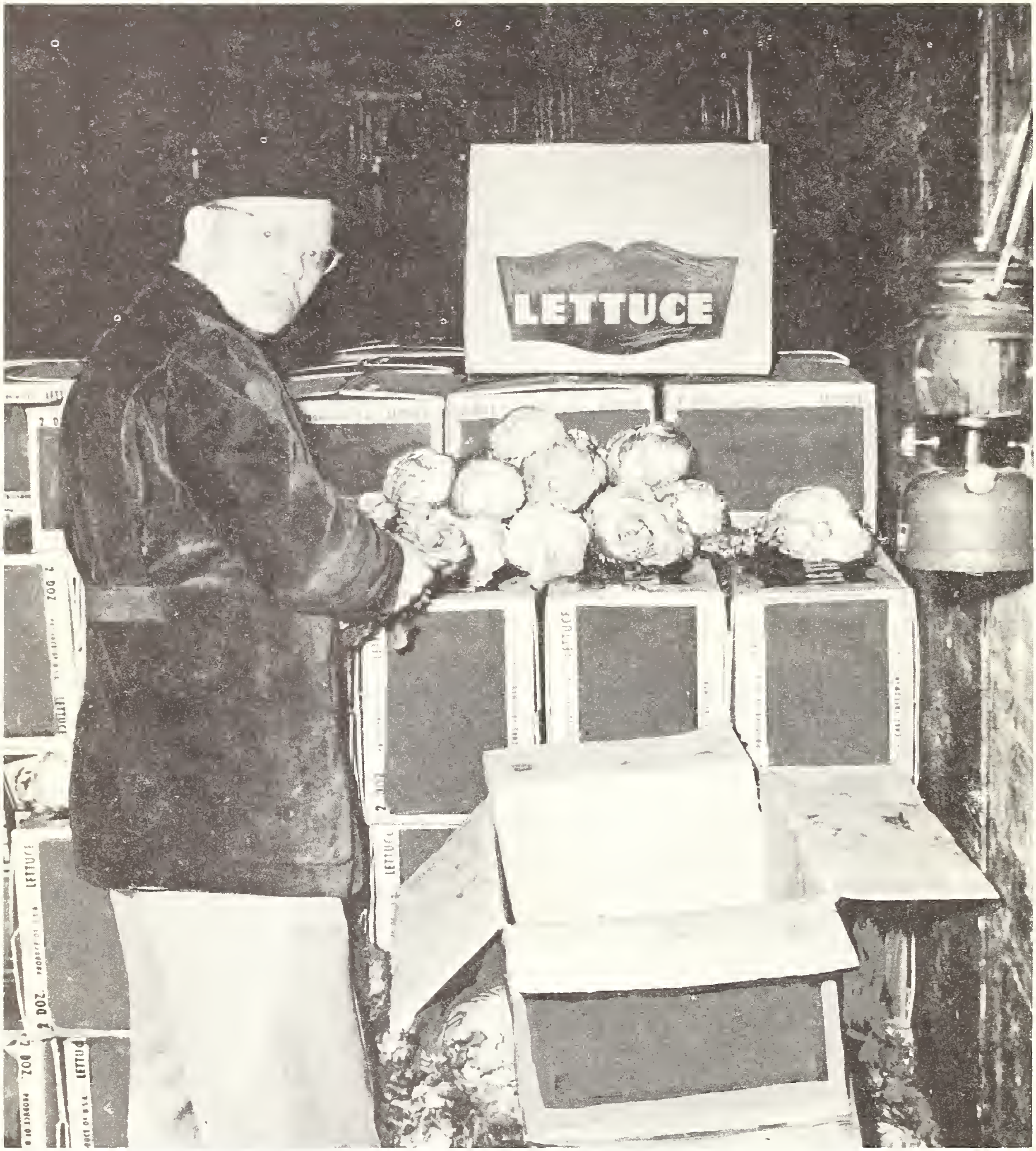

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Figure 3.--When shipments of lettuce arrived in the terminal market, sample containers were drawn from each quarter section of the car for inspection. Every head of lettuce was removed from the sample containers for individual inspection. Here is an inspector at work.

The western unit checked out 1,047 commercial carload shipments of lettuce packed in the various containers under study. From these the eastern group selected 191 carloads for inspection. Of these, 166 were loaded with the 3 most generally used containers, 51 cars of one container, 53 of a second container, and 62 of a third. Another 25 carlots included 4 different containers in less general use.

A final 9 cars represented 3 replications of 3 controlled tests. The same 3 containers in most general use were shipped 3 times with a light pack of lettuce, 3 times with an average weight pack, and 3 times with a heavy pack. Each of the 9 cars, instead of being loaded throughout with containers all of the same kind, contained at least 8 sample packages of each of the 3 containers.

The lettuce in commercial shipments originated at 7 points in California and 4 in Arizona. Salinas topped all points in number of shipments with 70, and was followed in order by El Centro, Phoenix, Glendale, Blythe, Yuma, Holtsville, Mesa, Gonzales, Watsonville, and Brawley. There were 59 individual shippers.

All shipments were made in standard bunker-type refrigerator cars. The only difference was type of bunker: stationary or collapsible. In collapsible bunker cars the bunker was always extended and iced. The type of bunker did not influence the loading arrangement of the containers.

The governing freight container tariff authorized 4 general methods of loading a car, plus several variations to eliminate lengthwise slack. Because of the various sizes of containers and their widely varying degrees of top bulge, many shipments apparently could not be loaded in absolute compliance with the tariff provisions. A majority, or 123, of the inspected cars had a load count of 640 containers, 17 had a count of 540 containers, and 8 had 500 containers. The remaining cars were loaded with 24 different numbers of containers, ranging from 515 to 803.

Icing provided for the shipments varied according to time of year and point of origin. Six different icing rules or combinations of rules were applied. The first shipment evaluated was made in the summer of 1954 and the last in the winter of 1955.

The railroads routed the cars in accordance with instructions from buyer, consignee, or shipper. The cars which were inspected at destination traveled over 67 different routes. In accordance with the plan, almost all the cars were unloaded in the New York metropolitan area. There were 27 receivers--one took 42 carloads, one took 34, one took 17, and the rest from 14 to 1.

Information recorded by the inspection team in the western producing areas included:

Shipping point inspection: Shipping point, name of shipper, variety of lettuce and size of pack, percentage of defects, brand name, type of container, method of closure, date loaded, load count, car number, location of test equipment, protective service, routing, destination, name and address of receiver, and estimated time of arrival. There also was a notation on whether the shipment had received Federal-State inspection.

Information recorded by the inspection team in the terminal market included:

Loading methods.--Location of on-side or on-bottom storage, number of layers, number of rows, number of stacks, and degree of shift. The loading pattern also was recorded graphically by diagram.

Weight and temperature.--As the cars were being unloaded in the eastern terminal markets, 12 sample packages were selected, 3 from each quarter section of the car. Pulp temperature of the lettuce in each package was taken with a stick thermometer. The containers were weighed.

Grade and condition of lettuce.--General factors noted included solidity of head, pack sizing, and wrapper leaf formation. Defects noted included slight, moderate, or serious bruising, soft heads and open heads, leaf and midrib discoloration, and mechanical injury. Personnel of the Federal Inspection Service of the Fruit and Vegetable Division of the Department conducted approximately 30 percent of the inspections and their methods and procedures were followed in all inspections.

Container damage.--Damage of fiberboard boxes was listed under three categories: open or torn cover flaps, torn boxes, and creased or crushed boxes. Each type of damage was classified as serious or non-serious. Non-serious damage was that affecting the appearance of the container only. Serious damage was considered to be such as to detract from marketability or to impair the ability of the containers to stand up under additional handling, transportation, or stacking.

Six degrees of damage for fiberboard containers were classified as (1) creased or crushed to extent which might impair sale or make future handling difficult, (2) torn 2 inches or more, (3) all 4 flaps sprung or open, (4) torn less than 2 inches, (5) from 1 to 3 flaps sprung or open, and (6) creased, scratched, or defaced to extent of affecting appearance only.

Description of Shipping Containers

All fiberboard containers observed differed for the most part only in dimensions. All were regular slotted containers constructed of a single piece of double-faced corrugated fiberboard possessing a test strength of not less than 275 pounds when dry and 100 pounds after 24 hours of immersion in water.

Each container had 4 top and 4 bottom flaps. The outer top and bottom flaps were of such depth that, when folded over to form top and bottom, they were not more than a quarter inch apart. The inner top and bottom flaps had a depth of at least 6½ inches. The sides of the box forming the corner joint overlapped at least 1½ inches and were fastened with at least 5 metal staples.

The wirebound crate was made of 4 veneer side slats, 2 for each side; 3 veneer bottom slats, 3 veneer top slats, 4 side cleats, 4 top and bottom cleats, 4 binding wires, and 2 end units. Each end unit included 3 veneer slats, 2 veneer strips, and binding wires.

The kraft veneer box consisted of a sheet of veneer with heavy kraft paper laminated on either side. This blank was wrapped around and nailed to two end frames of wooden post and rail construction to form bottom, sides, and top.

Eight of the 10 containers used by the western lettuce industry were packed with 2 dozen heads. The common standard pack was 4 heads long and 3 wide, 2 layers deep. Dimensions and capacities of the containers observed in the preliminary survey are listed in table 1. Containers designated 7300 to 7305 are identified by numbers assigned to them in Freight Loading and Container Tariffs. In the 85 series the containers are identified by experimental permit numbers issued by the National Container Committee of the Association of American Railroads.

Table 1.--Dimensions and capacities of containers used in lettuce shipments from California and Arizona, 1954-55

Container designation	Inside dimensions			Capacity	Usual number of heads packed
	Depth	Width	Length		
	Inches	Inches	Inches	Cubic inches	Dozen
7300 fiberboard box	9 1/2	13 1/2	20 1/2	2629	2
7301 fiberboard box	9	13	21 5/8	2531	2½
7302 fiberboard box	9	14 1/4	21 5/16	2733	2
7303 fiberboard box	10	14 1/4	21 5/16	3037	2
7304 fiberboard box	10 1/2	15	17	2678	1½
7305 fiberboard box	10 1/2	13 1/2	20 1/2	2906	2
85-122 wirebound crate	10	14 1/4	21 1/2	3064	2
85-285 fiberboard box	9	13	19	2223	2
85-286 fiberboard box	10 3/4	16	21 7/8	3763	2
85-958 kraft veneer box	10	14 1/4	20 3/4	2957	2

Extent of Use of Different Containers

The containers most generally used in 1954-55 and the ones on which emphasis was placed in this study were the 7300, the 7302, and the 7303. It was estimated that 53 percent of all California and Arizona lettuce shipped out of State was packed in the 7303 container, 25 percent was packed in the 7300, and 12 percent in the 7302.

Shipments in all other containers combined were about 10 percent of the total. The performance of 4 of these containers was observed in a limited number of commercial shipments. These included fiberboard boxes numbered 7305, 85-285, and 85-286, and a wirebound crate numbered 85-122. The wirebound crates performed well but because they were packed and loaded with special care for military export they were not included in the tabulations of containers packed and loaded for routine domestic shipments. Most of the export lettuce was individually wrapped in parchment type paper, some in cellophane.

Attempts to observe and evaluate the kraft veneer container were unsuccessful because all shipments checked out at point of origin were diverted en route before reaching the terminal markets where they were scheduled for inspection. Nor did the evaluations include fiberboard boxes 7301 and 7304. The former was designed especially for the relatively uncommon 2½-dozen pack and the latter for the equally uncommon 1½-dozen pack. Almost 95 percent of western dry-pack lettuce shipments were in the 2-dozen size.

Weight of Lettuce Packed in Alternative Containers

When members of the eastern terminal inspection unit met commercial carloads of lettuce upon arrival in the metropolitan markets, they selected 3 containers at random from each quarter section of the car. The full containers were weighed, then emptied of lettuce and the containers alone were weighed. The difference between full and empty weight or tare weight was tabulated as the net weight of the lettuce.

The 166 commercial shipments of lettuce in the 3 most generally used containers were divided almost equally among light, medium, and heavy packs. These weight ranges, determined by listing all pack weights from lightest to heaviest, were found to be less than 39.50 pounds, from 39.50 to 42.50 pounds, and more than 42.50 pounds (table 2).

The listing indicated that 58 carlots were in the light range, 55 carlots in the medium range, and 53 carlots in the heavy range.

Table 2.--Net weight of lettuce packed in 3 generally used containers, 166 shipments, 1954-55

Net weight in pounds	Shipments made in container		
	7300	7302	7303
	Number	Number	Number
30	1	---	---
31	1	---	---
32	3	---	---
33	1	---	---
34	1	---	---
35	5	1	---
36	6	1	---
37	4	3	1
38	5	7	---
39	10	7	1
40	7	14	6
41	2	9	6
42	1	3	7
43	3	1	9
44	1	1	12
45	---	3	8
46	---	1	5
47	---	1	4
48	---	---	2
49	---	---	---
50	---	1	1
Total	51	53	62

Most of the 7300 containers were packed light with small lettuce; more than half the 7302's held lettuce of medium size and weight, and most of the 7303's had heavy packs. The variation in weight of pack from light to heavy corresponded with the variation in the capacity of the containers (table 3). This direct relationship between weight of pack and size or capacity of container was apparent both among the generally used containers and those in more limited use.

Table 3.--Comparison of capacity of containers and average net weight of lettuce, 179 commercial shipments, 1954-55

Container designation	Number of shipments	Container capacity	Average net weight of pack
		Cubic inches	Pounds
85-285	4	2,223	35.8
7300	51	2,629	37.6
7302	53	2,733	40.4
7303	62	3,037	43.5
85-54	4	2,906	43.7
85-286	5	3,763	48.3

EVALUATION OF ALTERNATIVE CONTAINERS

Condition of Containers on Arrival in Terminal Markets

The type, extent, and severity of container damage suffered in transit was observed and recorded. To facilitate comparisons, specific classifications of damage were established, considerably more rigid than the standards employed in the trade.

Although impact recorders were placed in 40 cars, no direct relationship was found between severity of impacts recorded and percentage of containers sustaining serious damage. Nor was any significant difference noted in the percentage of container damage with relation to methods of loading the containers in the cars--either on bottoms or on sides.

Container 7300, which carried the lightest pack of the 3 principal containers, sustained the least combined serious and non-serious damage (table 4). The much less frequently used container 85-285, which was the most lightly packed container of all, had the least amount of serious damage and was second to the 7300 in combined damage. The 7303 and 7302, with heavier packs, were in third and fourth place in total damage sustained.

Torn containers - serious damage.--The most common type of serious damage consisted of tears more than 2 inches long--usually in the form of split corners (fig. 4). Such damage occurred in all parts of the car but was somewhat more prevalent where the loads had shifted. Tearing seemed to be associated with heavier net weights and overpacking of the containers. Among the 3 principal containers the 7303 had the most frequent damage in this category and the 7300 the least.

Table 4.--Comparison of damage to 6 containers in 179 commercial shipments, 1954-55

Container designation	Number of cars 1/	Containers damaged per car								
		Serious damage affecting future sale or handling				Non-serious damage--not materially affecting future sale or handling				Serious and non-serious
		Crushed	Torn 2/	4 flaps loose	Total 3/	Crushed	Torn 4/	1 to 3 flaps loose	Total 3/	Total 3/
		Number	Number	Number	Number	Number	Number	Number	Number	Number
7300	51	4.8	6.1	4.2	15.2	36.2	20.8	27.9	84.9	100.1
7302	53	3.2	6.9	8.4	18.5	61.9	31.2	45.3	138.4	156.8
7303	62	5.9	20.6	13.5	40.0	36.9	25.0	40.9	102.8	142.8
85-54	4	0.8	18.0	0.8	19.5	56.5	78.8	17.2	152.5	172.0
85-285	4	3.2	5.8	0.8	9.8	39.2	41.5	49.0	129.8	139.5
85-286	5	8.2	14.6	7.4	30.2	83.4	47.0	44.2	174.6	204.8

1/ Most common load was 640 containers per car.
2/ Torn 2 inches or more.
3/ Computed from basic data; not sum of rounded averages.
4/ Torn less than 2 inches.

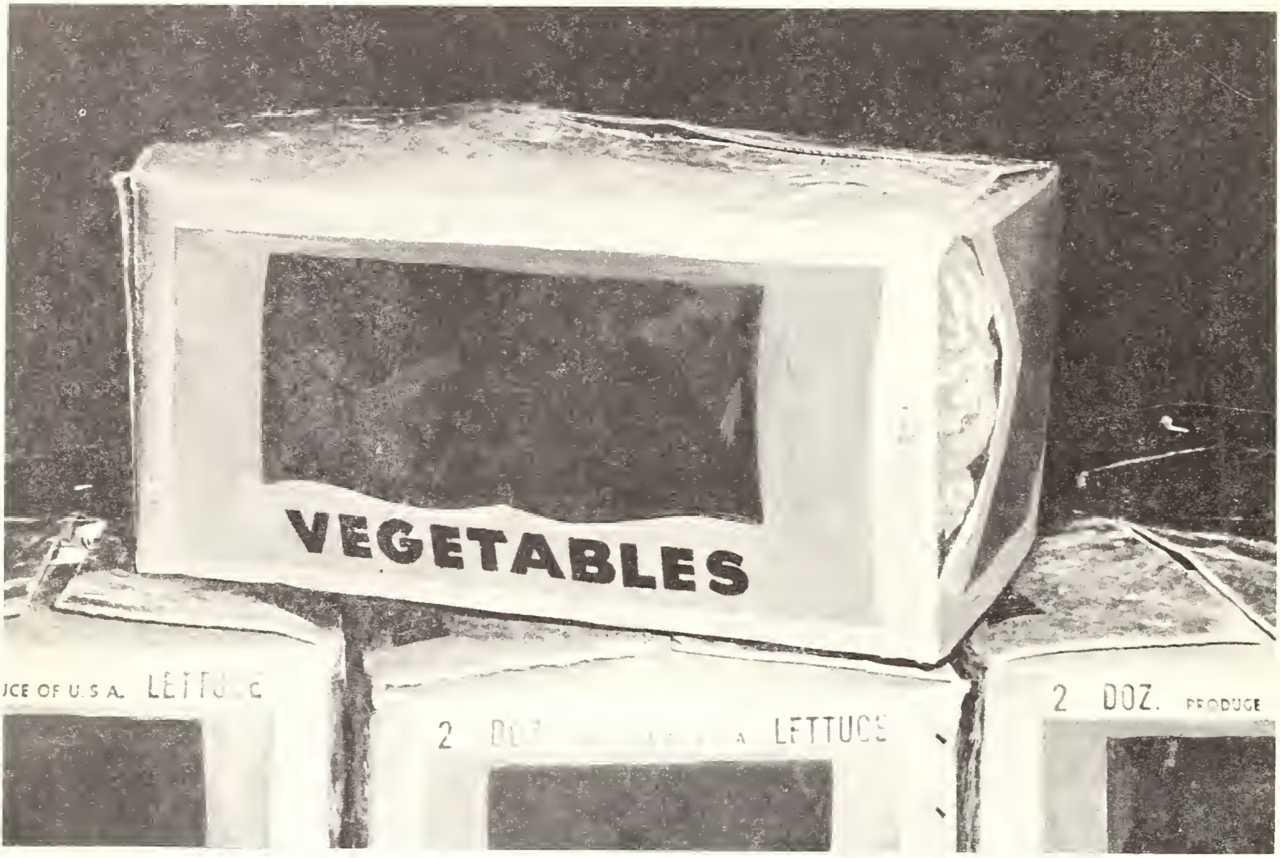

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Figure 4.--This container had a split corner. Tears more than 2 inches long, such as this, were listed as serious damage.

Crushed containers - serious damage.--Serious crushing was the least frequent type of serious damage and it generally occurred where there was a shift in the load (fig. 5). These crushed containers were found either in the doorway stacks where an irregular loading pattern was used or in the bunker stacks when the load had shifted enough to allow slack space between the bunker wall and the adjoining stack. Of the 3 principal containers the 7303 was most often crushed; 7302 the least.

All 4 flaps loose - serious damage.--There was some question as to whether 4 top flaps loose should be considered as serious damage. It was argued with merit that loose flaps usually resulted from careless closing and could easily be fastened or refastened at the terminal by the railroad cooper or the receiver. On the other hand, classification as serious damage indicated that future handling or sales could be affected. With the 4 flaps loose, handlers frequently spilled lettuce from the containers while unloading the cars. Also, 4 loose flaps invite pilferage. Tapered flaps were torn loose much more often than square flaps. The type of closure used did not seem to influence the incidence of loose flaps. All 4 flaps loose were observed most frequently among the most popular containers on the 7303 and least frequently on the 7300.

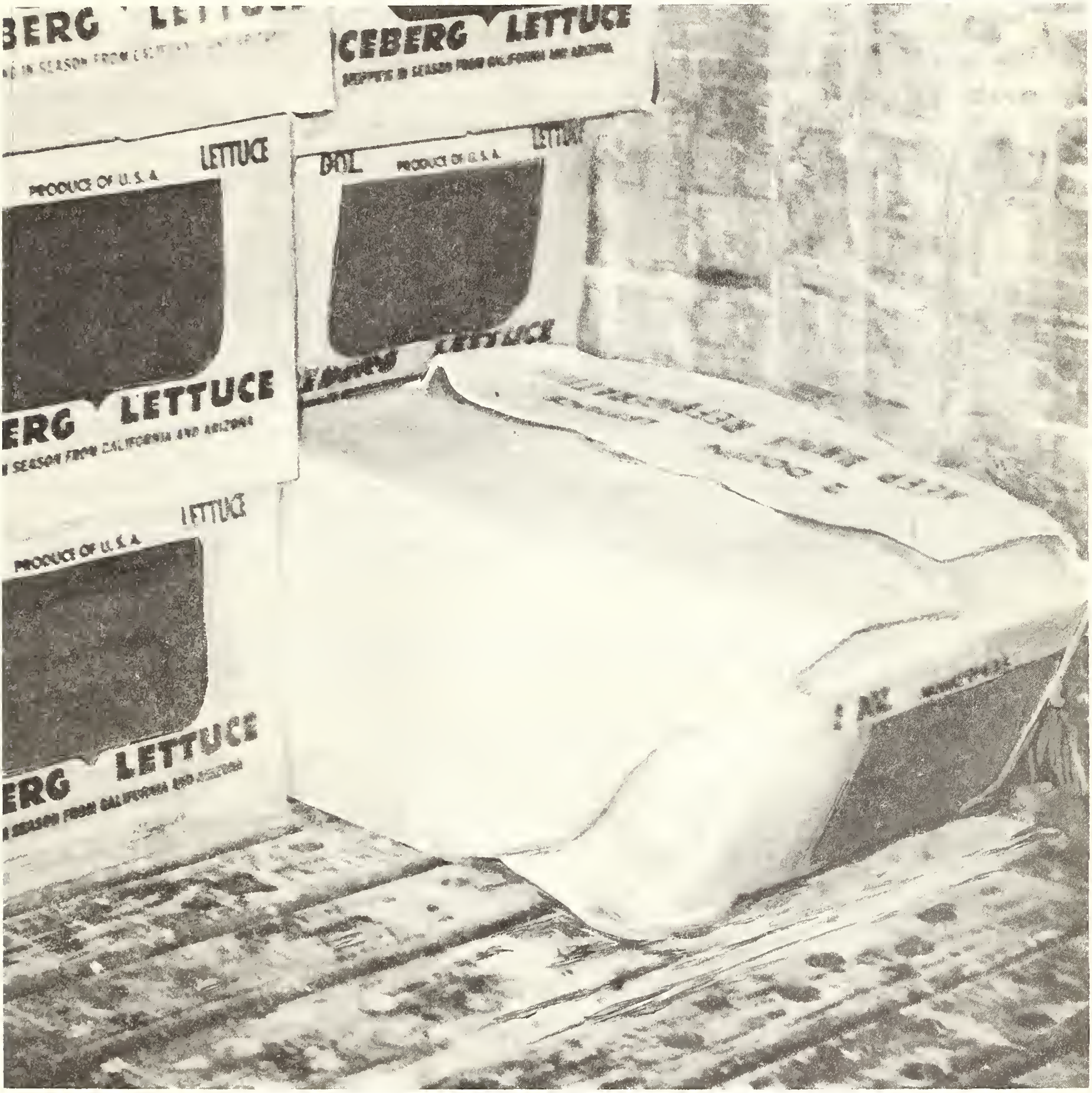

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Figure 5.--This container gives a good example of damage listed as severe crushing.

Non-serious damage.--On the average, from 14 to 28 percent of the containers in each carload were subjected to non-serious damage, which did not materially affect the future handling potential or sales of the containers. Minor crushing or creasing was the most usual form of non-serious damage followed in order by 1 to 3 loose cover flaps, and tears of less than 2 inches.

Ice water wet containers.--The railroads transported the lettuce in refrigerator cars with stationary bunkers and in cars with collapsible bunkers. Cars with collapsible bunkers had significantly more ice water wet containers than did cars with stationary bunkers. In 74 cars with collapsible bunkers an average of 5 wet containers was found in each car; in 92 cars with stationary bunkers an average of one wet container was found in every 4 or 5 cars.

Railroad inspections.--In the 166 commercial shipments of the 3 containers in most general use, the Railroad Perishables Inspection Agency reported 1,954 damaged containers which were made good and accepted by the receivers, and 310 "bad order" containers which were rejected. Damaged containers that were made good and accepted averaged about 12 per car. Rejected containers averaged about 1½ per car. Most of the rejected containers were part out or empty. Empty and part out containers sometimes resulted from pilferage. More often part of the contents was spilled or damaged. In this event, a number of part out containers with one or a few heads of lettuce missing or damaged were filled and made good from the contents of still another part out container. When all the contents had been removed from this latter container it was classed as empty and rejected.

Condition of Lettuce on Arrival in Terminal Markets

Commercial Shipments

As already noted, the containers inspected in commercial shipments were packed with lettuce varying in size and solidity, thus causing the weights of the pack to vary considerably. The average net weight of the pack in all shipments in the 3 main types of fiberboard boxes was 37.6 pounds in the 7300, 40.4 pounds in the 7302, and 43.4 pounds in the 7303. The range of the average net weight of pack per shipment in the 7300 was from 29.86 to 44.09 pounds, in the 7302 from 34.96 to 50.08 pounds, and in the 7303 from 37.47 to 49.55 pounds. Weight to a large extent was a measure of maturity--the greater the weight the more advanced the maturity. Since the tendency to bruise increased with maturity it was considered advisable to compare only containers packed with lettuce of the same weight or maturity.

Only the containers in most general use could be divided into weight classes and still have enough containers in each class to be considered a representative sample.

Data obtained from observations of the arrival condition of 166 carloads of lettuce packed in the three most generally used containers were analyzed not only for relationship between container and lettuce bruising but also for relationship between weight-of-pack and lettuce bruising. Thirteen shipments in 3 less generally used containers were not included in these tabulations.

The average container net weights per car in 166 commercial shipments were divided into light, medium, and heavy groups in two different ways as follows:

1. First, regardless of container, a light pack was arbitrarily considered any pack of less than 39.5 pounds, a medium pack between 39.5 and 42.5 pounds, and a heavy pack more than 42.5 pounds. Using these limits, roughly one-third of all containers fell into each group.

2. Later, shipments in each container type were divided into equal thirds, from lightest to heaviest. In the 7300 container, which was the smallest, light, medium, and heavy packs averaged 34.1, 38.0, and 40.8 pounds, respectively. In medium sized container 7302, light, medium, and heavy packs averaged 37.9, 40.0, and 43.3 pounds. In large container 7303, the packs averaged 40.4, 43.6, and 46.2 pounds.

Table 5 shows some of the principal features of the 166 carlot shipments grouped under the first method. This table shows that container 7300 was packed with predominantly light packs of lettuce, 7302 mostly light and medium, and 7303 largely heavy.

Table 5.--Average percent of total bruising by containers and net weight combinations, 166 commercial shipments, 1954-55

Weight range of pack	Container designation					
	7300		7302		7303	
	Carloads	Total bruising	Carloads	Total bruising	Carloads	Total bruising
	Number	Percent	Number	Percent	Number	Percent
Light (under 39.5 lb.) ...	37	17.5	19	13.0	2	26.0
Medium (39.5 to 42.5 lb.) .	10	16.6	26	13.8	19	16.2
Heavy (over 42.5 lb.)	4	21.0	8	22.5	41	24.0

Analyses of variance of parts of the data were computed on percentage of total bruising. Weights for a single container, and containers for a single weight, were compared, using only groups of 8 or more cars.

In the light weight, 7302 had significantly less bruising than 7300. In the medium weight, no significant difference was found among the 3 containers. In the heavy weight, 7302 and 7303 were obviously about the same. In 7300, light and medium weights did not differ significantly. In 7302, light and medium weights differed significantly from heavy, but not from each other. In 7303, heavy lettuce packs had significantly more bruising than medium.

There was thus not much evidence of difference among containers, but there was considerable evidence that heavy packs of lettuce were bruised more than light or medium. Hence, all 166 cars were combined in an analysis of variance comparing heavy lettuce with light and medium, disregarding containers. The 113 cars of light and medium lettuce had considerably less bruising than the 53 of heavy (15.7 percent versus 23.6 percent), and this difference was very significant, nearly 5 times its standard error.

Thus, container differences did not show up strongly, although container 7302 appeared a little better than the others. Heavy weight, on the other hand, definitely showed more bruising than light or medium pack.

The second method of grouping containers by weight of pack in each container type was used in appraising data which are summarized in table 6. In this study total bruising was divided into slight to moderate, and serious head leaf bruising, and slight to moderate, and serious wrapper leaf bruising in 166 commercial shipments in containers 7300, 7302, and 7303. To examine the head leaves, all wrapper leaves were removed (fig. 6).

In general, there was a tendency for the incidence of serious bruising to go up as the average weight of the pack went up.

Serious head leaf bruising rose with increasing weight groups in container 7303. In containers 7300 and 7302 there was more serious head leaf bruising in the heavy pack than in the light or medium packs. However, the medium pack had slightly less serious head leaf bruising than the light pack in the 7302, and light and medium packs had the same amount of serious head leaf bruising in the 7300.

Serious wrapper leaf bruising increased regularly with the rise in average weight in containers 7300 and 7303. In container 7302 serious wrapper leaf bruising was greatest in the heavy group and equal in light and medium weight groups.

Slight to moderate head leaf and wrapper leaf bruising followed no consistent trend with changes in the average weight of the pack.

Table 6.--Percentage of head leaf bruising and wrapper leaf bruising by light, medium, and heavy packs, in containers 7300, 7302, and 7303, 166 commercial shipments, 1954-55

Container	Carlots	Weight group	Average weight of pack	Head leaf bruising		Wrapper leaf bruising	
				Slight to moderate	Serious	Slight to moderate	Serious
	Number		Pounds	Percent	Percent	Percent	Percent
7300	17	Light	34.13	7.5	0.1	9.6	0.1
Do.	17	Medium	37.98	6.6	0.1	12.4	0.2
Do.	17	Heavy	40.82	7.2	0.8	8.3	0.5
Do.	51	All	37.64	7.1	0.3	10.1	0.3
7302	18	Light	37.93	4.3	0.6	8.4	0.2
Do.	18	Medium	40.02	5.6	0.4	8.0	0.2
Do.	17	Heavy	43.29	5.9	1.2	10.9	0.6
Do.	53	All	40.36	5.3	0.7	9.1	0.3
7303	21	Light	40.85	5.4	1.1	9.7	1.1
Do.	21	Medium	43.58	9.6	1.4	12.2	1.7
Do.	20	Heavy	46.20	6.6	1.5	12.9	2.0
Do.	62	All	43.50	7.2	1.3	11.6	1.6

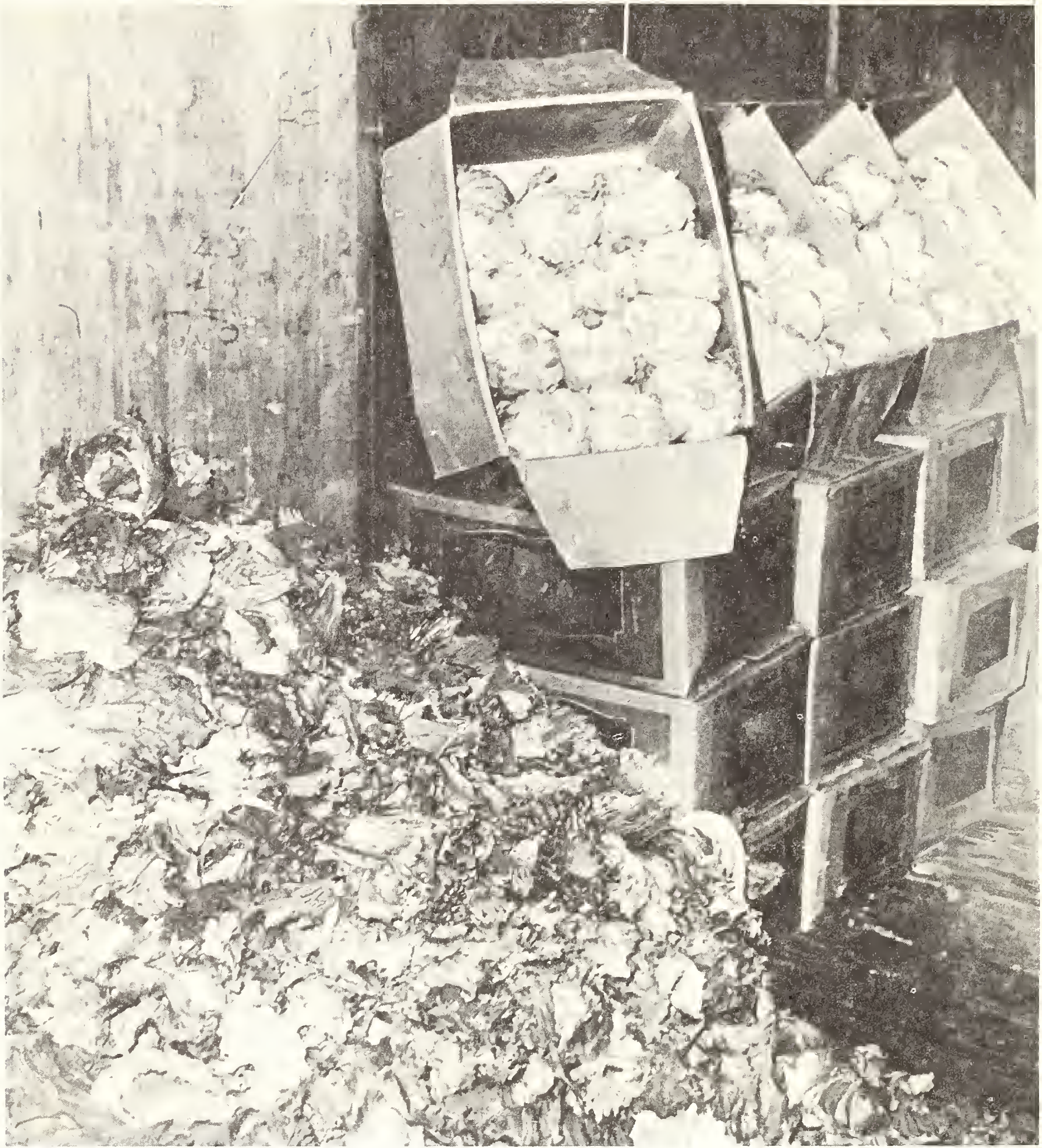

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Figure 6.--This heap of wrapper leaves was trimmed off by the terminal inspector to permit examination of the head leaves. Very little serious bruising was sustained by either wrapper leaves or head leaves.

In comparing containers--instead of weight groups in the same container--it was found that serious head leaf bruising also was slightly higher in the containers with the heavier packs. Container 7300, whose average pack weights were the lightest, had the least serious head leaf bruising, and container 7303, with the heaviest packs, had the most. In container 7302 the serious head leaf bruising was between the two extremes and the pack weight also was between the two.

Serious wrapper leaf bruising also was greatest in the container with the heaviest pack--the 7303. Containers 7300 and 7302 with the lightest and the medium packs had the same amount of serious wrapper leaf bruising.

Although not consistent in all weight groupings, container 7302 had the least overall slight to moderate head and wrapper leaf bruising.

Increases in serious bruising within each container may have been influenced by tightness of pack as well as by weight of the pack. As the weight of the lettuce packed in a given container became heavier (and larger), the available space remained constant. Therefore, it was necessary to compress the lettuce tighter in the heavier packs. As indicated in table 7, lettuce in a single container, as for example the 7300, might be packed from an average of 1.30 pounds per 100 cubic inches in the light grouping to 1.55 pounds per 100 cubic inches in the heavy grouping.

Table 7.--Weight-space relationship (tightness) of lettuce packed in containers 7300, 7302, and 7303, 166 commercial shipments, 1954-55

Container designation	Weight group	Average net weight	Container capacity	Weight per 100 cubic inches
		Pounds	Cubic inches	Pounds
7300	Light	34.13	2,629	1.30
Do.	Medium	37.98	2,629	1.44
Do.	Heavy	40.82	2,629	1.55
Do.	All	37.64	2,629	1.43
7302	Light	37.93	2,733	1.39
Do.	Medium	40.02	2,733	1.46
Do.	Heavy	43.29	2,733	1.58
Do.	All	40.36	2,733	1.48
7303	Light	40.85	3,037	1.35
Do.	Medium	43.58	3,037	1.43
Do.	Heavy	46.20	3,037	1.52
Do.	All	43.50	3,037	1.43

It was noted that the light pack in all 3 containers fell into a weight-space relationship in the range between 1.30 and 1.40 pounds per 100 cubic inches; the medium pack between 1.40 and 1.50 pounds and the heavy pack between 1.50 and 1.60 pounds. Weight-space relationship is a measure of tightness of pack.

Table 8 shows the average amount of serious bruising in all 3 containers by weight group of pack and by weight-space relationship range. Study of this table permitted some theoretical computations which, in view of subsequent developments, are of considerable interest.

Table 8.--Average percentage of serious head leaf bruising and serious wrapper leaf bruising in containers 7300, 7302, and 7303, by weight group and by weight-space (tightness) range, 166 commercial shipments, 1954-55

Weight group of pack	Average weight range per 100 cubic inches	Average serious head bruising	Average serious wrapper bruising
	Pounds	Percent	Percent
Light	1.30 to 1.40	0.6	0.5
Medium	1.40 to 1.50	0.6	0.7
Heavy	1.50 to 1.60	1.2	1.0

A general tendency for serious bruising of lettuce to increase as the weight of the pack went up already has been noted. Yet, average serious bruising in the medium weight packs in all containers was for all practical purposes almost the same as the percentage of serious bruising in the light packs (table 8). The medium packs in all containers had a weight-space (tightness) relationship in the range between 1.40 and 1.50 pounds per 100 cubic inches. The midpoint of this range was 1.45 pounds. Bruising in the 1.50 to 1.60 pound range was considerably higher.

Thus it was possible to conclude that the weight-space relationship in the 1.40- to 1.50-pound range probably was a good one from the viewpoint of the protection of the lettuce from serious damage. In the lower range available space in the containers would not be employed to the fullest economic advantage and in the higher range serious bruising would be increased appreciably.

A single "standard" container--an industry goal--must be designed for the average pack of lettuce. The average pack in all containers in the 166 commercial shipments examined was 40.70 pounds. If 1.40 to 1.50 pounds per 100 cubic inches was the ideal relationship, then a container with a capacity of approximately 2,810 cubic inches should be a good one for the average pack of 40.7 pounds. This was between the 2,733 cubic inches of the 7302 container and the 3,037 cubic inches of the 7303 container, and close to the 2,866 cubic inches of the present standard container recently adopted by the industry.

Controlled Test Shipments

In order to control variables, a special 9-car test was conducted. Light, medium, and heavy groupings of the lettuce pack were established as suggested by the average weights noted in all containers in commercial shipments. The test shipments were packed under the direction of research technicians and the pack weights were held within 2-pound group or class limits. The light pack was between 36 and 38 pounds, the medium between 40 and 42, and the heavy between 44 and 46.

All 3 of the containers in most general use were shipped in the same car. In 3 carlots the containers were all packed within the light range, in 3 carlots the containers were all packed within the medium range, and in 3 carlots the containers were all packed heavy (fig. 7).

Terminal market inspections revealed clearcut differences in bruising of the lettuce among containers, and among light, medium, and heavy packs in the same container.

Lettuce in the 7303 containers--the largest of the 3 tested--showed the least total bruising with all 3 weights of pack. The 7300--the smallest container--had the most bruising in all weight classes. In all containers, the greater the weight of pack the greater the amount of bruising (table 9).

A statistical analysis of variance was computed and the differences in total bruising were found to be statistically significant.

For a more detailed picture of what injuries were sustained by the lettuce, wrapper leaf bruising and head leaf bruising were noted separately (table 10). Total wrapper leaf bruising was significantly greater in the heavy pack than in the light or medium pack. There also appeared to be appreciably less total wrapper leaf bruising in all pack weights in the 7303 container but the differences between this and the other containers were not significant.

With the total head leaf bruising, both packs and containers showed significant differences. The light pack was bruised less than either medium or heavy packs. All weight packs were bruised the least in container 7303. It was larger than the 7300 and 7302 and for the weights of lettuce packed for the 9-car test it apparently permitted a better weight-space relationship.

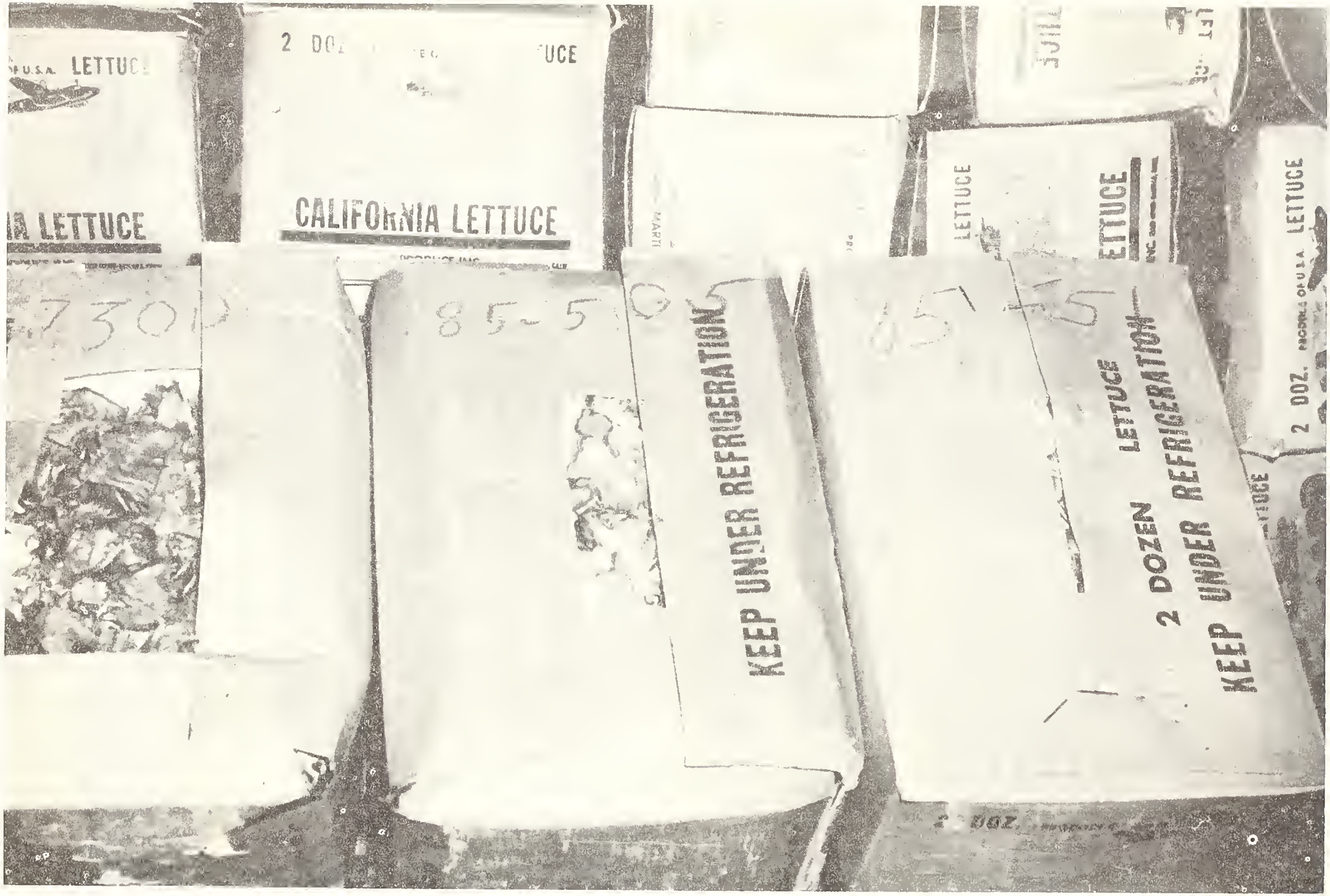

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Figure 7.--The same weight of lettuce was packed in all 3 of these containers. In the smallest container, the 7300 on left, the flaps could scarcely be closed. In the medium container, the 7302 in center, the opening between flaps was 2-3/4 inches. The same amount of lettuce fit easily into the largest container, the 7303 on right. Here the opening between the flaps was a scant half inch.

Table 9.--Average percent total bruising for container-pack combinations, special 9-car test, 1955-56

Pack	Container designation 7300	7302	7303
	Percent	Percent	Percent
Light (36 - 38 lb.)	19.3	15.1	13.5
Medium (40 - 42 lb.)	37.8	26.0	18.6
Heavy (44 - 46 lb.)	46.0	39.9	22.9
Average	34.4	27.0	18.3

Table 10.--Percentage of slight and moderate bruising, serious bruising, and total bruising of wrapper leaf and head leaf by pack and by container, 9 test shipments of lettuce, 1955-56

Pack or container	Wrapper leaf bruising: Slight to moderate	Wrapper leaf bruising: Serious	Wrapper leaf bruising: Total	Head leaf bruising: Slight to moderate	Head leaf bruising: Serious	Head leaf bruising: Total
	Percent	Percent	Percent	Percent	Percent	Percent
Pack (all containers)						
Light	10.8	0	10.8	5.0	0.2	5.2
Medium	11.3	0.8	12.1	13.2	2.2	15.4
Heavy	19.3	1.9	21.2	10.0	5.0	15.0
Container (all packs)						
7300	16.4	1.3	17.8	13.8	2.8	16.6
7302	14.0	1.2	15.2	8.4	3.4	11.9
7303	11.1	0.1	11.2	6.0	1.2	7.2

This clearcut difference among the containers in the controlled test shipments was in sharp contrast to the slight shades of difference noted in the 166 commercial shipments but the reason was obvious. In the routine commercial shipments the growers quite naturally put predominantly light packs in the small 7300 container, light and medium packs in the medium sized 7302 and heavy packs in the large 7303. On the other hand, in the controlled test shipments the research technicians packed the same weights in all three containers.

All observations have indicated that bruising mounted as weight of pack increased. With lettuce, weight is an indirect measure of volume--heavier packs are larger than light ones. Heavier packs (larger in volume) must be compressed tighter than light packs to fit in the same unit of space. Thus, a heavy pack indicates a tight pack, the containers being equal.

The weight-space relationship was determined for all pack weights in all containers as grouped in table 9. This weight-space relationship is simply a measure of the tightness of the pack--expressed in pounds of lettuce per 100 cubic inches of space available within the container.

The weight-space relationships as determined are listed in table 11 in sequence from the least tight pack to the tightest. Opposite each weight-space listing is the amount of total bruising found in the grouping in the 9-car test.

Table 11 indicates that as the pack became tighter total bruising increased. As the tightness of the pack rose from a minimum of 1.22 pounds per 100 cubic inches to a maximum of 1.69 pounds, the average total bruising mounted from 13.5 percent to 46.0 percent.

Analysis of the data from the 9 test shipments revealed a straight line relationship--often called a linear relationship--between tightness of pack and the percentage of total bruising. This relationship--which is shown graphically on page 28 --accounted for about one-half of the variation in total percent of bruising. Each dot on the chart indicates the average percent of total bruising and the average tightness of the lettuce packed in a single container type in 3 test shipments.

The solid line in the chart is the line of relationship along which the average percentage of bruising in a considerable number of shipments will tend to cluster. Bruising in any individual shipment may vary appreciably but in 95 percent of the shipments the percentage of such bruising will be within the bounds of confidence indicated on the chart by the dotted lines.

The relationship between tightness and bruising was much the same even when each container type was studied separately. However, it was noted that the relationship did not account for quite so much of the variation in bruising

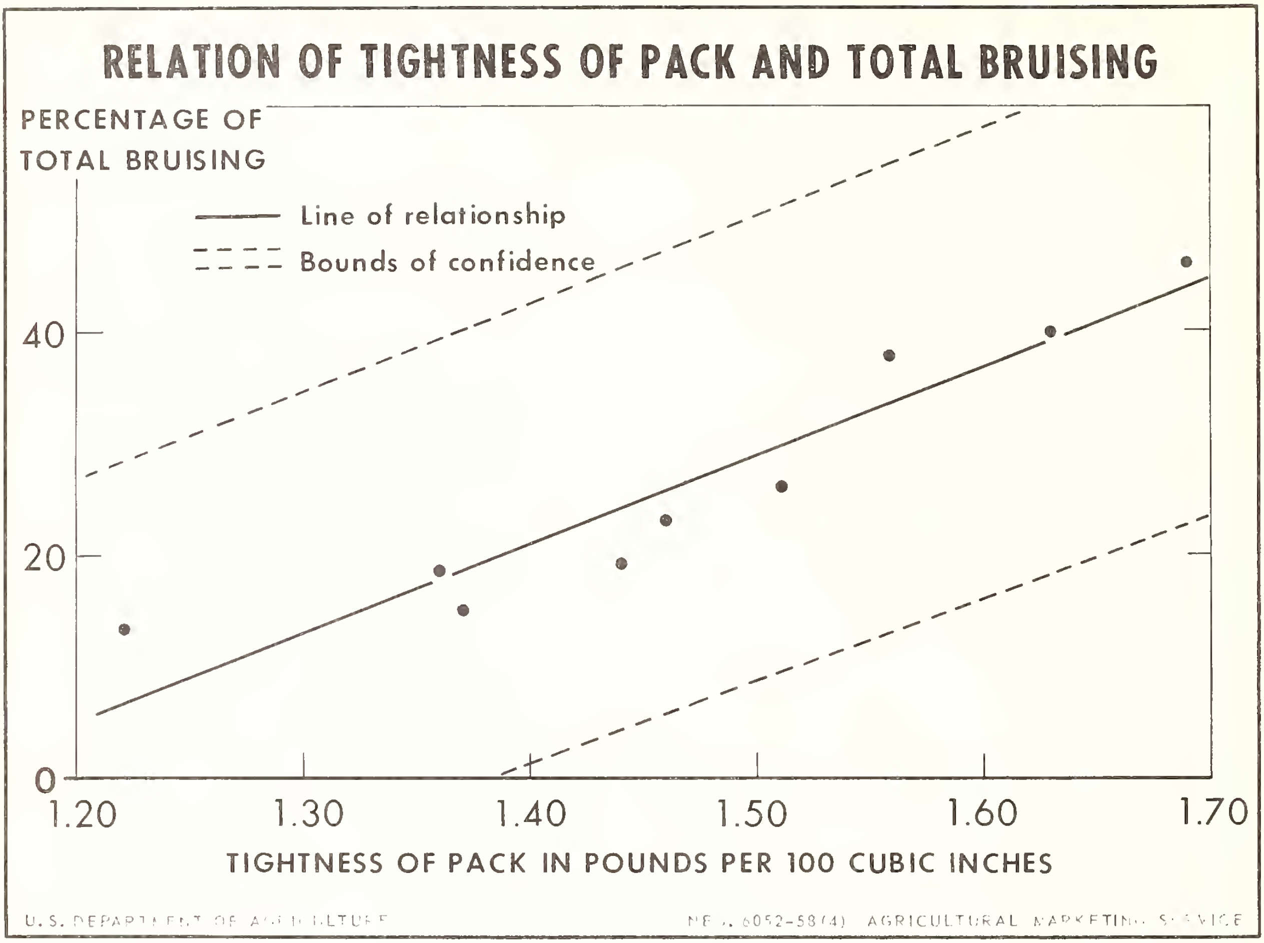
Table 11.--Relationship of tightness of pack and total bruising of lettuce, 9 controlled test shipments, 1955-56 1/

Container and treatment 2/	Average net weight of pack 2/	Tightness of pack 3/	Percentage of bruised heads
	Pounds	Pounds per 100 cu. in.	Percent
7303 packed light	37.33	1.22	13.5
7303 packed medium	41.24	1.36	18.6
7302 packed light	37.55	1.37	15.1
7300 packed light	37.90	1.44	19.3
7303 packed heavy	44.43	1.46	22.9
7302 packed medium	41.15	1.51	26.0
7300 packed medium	40.94	1.56	37.8
7302 packed heavy	44.58	1.63	39.9
7300 packed heavy	44.39	1.69	46.0

[1] Each observation is average of 3 shipments, 8 sample containers per shipment.

[2] Each container type was filled and shipped 3 times with a light pack of lettuce, a medium pack, and a heavy pack.

[3] Tightness of pack was computed by dividing net weight of lettuce by capacity of container. Container capacities are listed in table 1.



in the largest container, the 7303, as in the others. This shade of difference in the relationship might indicate that other causes of variation in total bruising were more important for the large containers than for the smaller ones. 4/

Lettuce packed 1.44 pounds per 100 cubic inches had little more total bruising than the lighter packs. Total bruising went up moderately at 1.46 and 1.51 pounds. Above 1.51 pounds the incidence of total bruising was much higher.

4/ For more complete discussion of analysis of data see appendix.

Average serious bruising also tended to rise as the tightness of the pack increased. At 1.44 pounds per 100 cubic inches and below that level, the percentage of serious bruising averaged less than 1 percent. At 1.46 pounds it was 2.8 percent and at 1.51 pounds it was 3 percent. In tighter packs the serious bruising ranged from an average of 5 percent to 10.6 percent.

Lettuce packed only 1.22 to 1.37 pounds per 100 cubic inches probably was not getting optimum economic use from the larger containers. Lettuce packed so low in the scale of tightness was wasting space, and as freight charges on lettuce are based on an estimated average weight per package, the shipper would be paying freight charges on more lettuce than he moved if he should consistently follow the practice of packing light.

In the previous discussion of the 166 commercial shipments it was concluded that a weight-space relationship between 1.40 and 1.50 pounds per 100 cubic inches appeared best for the weight and type of lettuce observed. Study of the data from the 9 controlled test shipments again seemed to indicate that, as a rough rule of thumb, an approximate level of 1.5 pounds per 100 cubic inches seemed like a workable upper limit in seeking economic use of the container and at the same time avoiding high rates of bruising.

PRESENT STATUS OF LETTUCE CONTAINERS

Use of the numerous containers in commercial shipments caused considerable confusion among receivers. This confusion was compounded by the fact that the same containers often were designated by two and sometimes by three different numbers.

At about the time the Western Growers Association was winding up the tests for the Department, lettuce growers and shippers of California and Arizona participated in a series of meetings to discuss the merits of the containers then in use and to seek agreement on a single fiberboard container acceptable to all. A new container, a compromise between the 7302 and the 7303 which had turned in the best performance in the USDA tests, finally was chosen in early 1956. It was the same type of fiberboard box with a capacity of 2,866 inches, a little larger than the 7302's 2,733 cubic inches and smaller than the 7303's 3,037 cubic inches. Inside dimensions were 9-3/4 by 14 by 21 inches.

The new container was given permit status and was assigned designating number 85-601 in the spring of 1956. A green light for unrestricted use of the container was flashed when it was designated the 7306 and published in Freight Container Tariff 1-E for the Pacific Coast and Transcontinental Territories, effective July 3, 1956. An estimated tariff billing weight of 43 pounds was assigned. Meanwhile the 7300, 7302, and 7303 were withdrawn from the railroad tariffs.

Legislative amendments in 1957 removed 9 of the 11 standard containers from the California Agricultural Code. Following the amendment, only one wooden container and the new standardized fiberboard box known as the 7306, continued to be authorized by the State code. Arizona took similar action. The wooden container, which is 14¼ by 18¼ by 20½ inches, is used almost entirely for local shipments to West Coast markets and the new fiberboard box is used for shipments to eastern markets.

Computations from observations of 166 commercial shipments indicated that a container with a capacity of 2,810 cubic inches seemed theoretically ideal for lettuce of the average weight observed in 1954-55 (assuming of course that each of the 3 dimensions is in correct proportion to the other 2). This computed capacity was so close to that of the 7306 standard fiberboard container now in general use that it may well be concluded that the lettuce growers have made a wise choice.

If improved cultural practices and the introduction of new strains continue the trend to larger lettuce, one may quite naturally expect more dimensional changes in the lettuce containers of the future.

APPENDIX

Comments on Analysis of Data from 9 Controlled Test Shipments 5/

1. A linear relation between total percentage of bruising and tightness of pack accounted for about one-half the variation in the total percentage of bruising noted in the 9-car controlled test shipments of lettuce. A sketch of the best fitting straight line is given on the chart in fig. 9. This straight line (solid line on chart) accounts for almost all of the relationship between the two measurements and there is no evidence of curvalinearity. The straight line was fitted by the formula:

$$\underline{Y} = -85.3639 + 76.37\ X$$

The dotted lines were fitted by the formula:

$$Y' = \underline{Y} \pm 2.060 \sqrt{64.8254 + 24.6388\ X}$$

The dotted lines form a confidence bound for the points on the fitted line.

An example may help clarify the chart.

Using the formula designated as $\underline{Y}$, a value of $\underline{Y}$ is found for any value of X, say 1.47. For this value $\underline{Y} = 26.9$. From the formula designated as Y', two values, 6.20 and 47.60 are obtained for the lower and upper confidence bounds. With this information the statement can be made that, for X = 1.47, the limits for $\underline{Y}$ will be more than 6.20 but less than 47.60, and this statement will hold 95 percent of the time. For any particular shipment for which the tightness of the pack is 1.47, the total percent bruising may or may not be within these limits, but if one considers many shipments, each of which has a tightness value of 1.47, the 95 percent confidence bounds apply.

The limits computed for the example are quite broad and show that there is considerable variation in percentage of total bruising when tightness of pack is held constant. The fact that the confidence bounds are practically parallel with the fitted line indicates that this situation exists for any value of tightness of pack which might be considered. This picture indicates that the remaining portion of the variation in percentage of total bruising is arising from other sources than tightness of pack alone, and that these sources are such that they influence percent bruising about the same amount regardless of tightness of pack.

2. To investigate the possible influence of container type, a separate line was fitted for each type of container. The analyses showed that a linear relation was the best representation of the relationship between tightness of pack and total bruising percentage for each type and that the same line

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5/ Prepared by Therese Kelleher, mathematical statistician, Division of Statistical Standards, Agr. Mktg. Serv., U. S. Dept. Agr.

could be used for the three container types. Consequently, the average line discussed in (1) is applicable for the various types. However, it was noted that the relationship did not account for so much of the variation in total bruising in the large container as it did in the other two. The difference was not large enough to justify using a line of different slope for the large container but might indicate that other sources of variation were more important for large containers. However, the main difference in container type was found to be due to variations in tightness of pack and therefore the difference noted in the previous statement is of secondary importance at most.

The means of the container types were first compared without regard to tightness of pack and were found to differ considerably. They were then adjusted for tightness of pack, that is to say, the differences among the means due to differences in tightness of pack were removed. The adjusted means were nearly equal, which establishes that the primary reason for different amounts of bruising in the container types is the relationship with tightness of pack. The average correlation coefficient in the three containers was .74.

Table 12.--Percentage of head leaf bruising and wrapper leaf bruising by individual shipments from lightest to heaviest and by light, medium, and heavy packs in container 7300, 51 commercial shipments, 1954-55

Shipment	Code	Net weight	Head leaf bruising		Wrapper leaf bruising	
			Slight to moderate	Serious	Slight to moderate	Serious
No.	No.	Pounds	Percent	Percent	Percent	Percent
			LIGHT PACK 1/			
1a	128	29.86	6.2	0	9.0	0
2a	109	31.18	3.1	0	12.8	0
3a	137	31.94	9.4	0.3	9.4	0
4a	115	32.25	21.5	0	8.7	0
5a	111	32.37	1.4	0	8.3	0
6a	138	33.03	2.4	0.3	8.3	0
7a	139	34.41	2.1	0	6.3	0
8a	140	34.72	3.1	0	0	0
9a	129	34.88	13.5	0	12.5	0
10a	112	34.97	9.7	0	13.5	1.7
11a	142	35.16	6.9	0	6.6	0
12a	119	35.22	9.0	0	12.8	0
13a	126	35.64	7.3	0	8.3	0
14a	134	35.98	13.5	0.3	16.0	0.3
15a	114	36.12	8.7	0	13.9	0
16a	135	36.15	2.4	0	7.3	0
17a	23	36.35	6.9	0.7	9.0	0
Average light pack 2/		34.13	7.5	0.1	9.6	0.1
			MEDIUM PACK 3/			
18a	44	36.48	5.6	0.7	6.3	0.7
19a	125	36.58	6.9	0	8.0	0
20a	105	37.10	2.1	0	16.3	1.0
21a	106	37.40	0	0	14.6	0
22a	110	37.42	16.3	0	20.1	0
23a	108	37.56	5.9	0	19.8	0
24a	120	37.66	18.8	0	21.2	0
25a	141	37.94	4.5	0	6.9	0
26a	219	38.04	2.1	0	11.8	0
27a	116	38.37	13.5	0	8.3	0
28a	113	38.53	3.1	0	16.3	0
29a	107	38.55	8.3	0	23.6	0
30a	10	38.61	1.8	0	3.4	0
31a	133	38.67	12.2	0.3	18.8	0
32a	150	38.68	6.9	0	8.7	0
33a	23	39.00	3.1	0.7	7.6	1.7
34a	31	39.05	2.4	0.7	2.8	0
Average medium pack 2/		37.98	6.6	0.1	12.4	0.2

Continued ....

Table 12.--Percentage of head leaf bruising and wrapper leaf bruising by individual shipments from lightest to heaviest and by light, medium, and heavy packs in container 7300, 51 commercial shipments, 1954-55--Continued

Shipment	Code	Net weight	Head leaf bruising		Wrapper leaf bruising	
			Slight to moderate	Serious	Slight to moderate	Serious
No.	No.	Pounds	Percent	Percent	Percent	Percent
HEAVY PACK 4/						
35a	123	39.24	4.9	1.0	6.2	0
36a	26	39.28	2.8	0.7	5.2	0.7
37a	144	39.36	12.8	0	0.3	0
38a	3	39.66	7.3	0	9.4	0
39a	70	39.71	6.2	0	15.3	0
40a	121	39.73	12.5	0	11.5	0
41a	104	39.75	1.0	1.7	13.9	1.4
42a	29	39.83	0.3	0.7	0.7	0.3
43a	143	39.91	6.9	0	10.1	0
44a	117	40.21	10.4	0	14.9	0
45a	118	41.25	8.0	0	15.6	0
46a	35	41.48	3.5	0.7	2.8	0
47a	18	42.14	4.9	1.6	6.0	1.3
48a	16	42.53	9.6	2.9	10.9	2.6
49a	88	42.72	19.8	0	5.2	0
50a	21	43.02	3.6	0	4.9	0
51a	46	44.09	7.6	5.2	8.7	2.4
Average heavy pack 2/		40.82	7.2	0.8	8.3	0.5

1/ One-third of shipments with lowest pack weights.

2/ Percentages computed from total number of bruised heads and total number of heads in samples--not from sum of individual rounded averages.

3/ One-third of shipments with medium pack weights.

4/ One-third of shipments with highest pack weights.

Table 13.--Percentage of head leaf bruising and wrapper leaf bruising by individual shipments from lightest to heaviest and by light, medium, and heavy packs in container 7302, 53 commercial shipments, 1954-55

Shipment	Code	Net weight	Head leaf bruising		Wrapper leaf bruising	
			Slight to moderate	Serious	Slight to moderate	Serious
No.	No.	Pounds	Percent	Percent	Percent	Percent
LIGHT PACK 1/						
1b	127	34.96	9.4	0.3	13.5	0
2b	124	36.18	3.8	0	6.6	0
3b	145	36.55	3.5	0	6.2	0
4b	200	37.16	0	0	12.8	0
5b	146	37.30	5.6	0	6.6	0
6b	173	37.54	5.6	0.3	7.6	0.3
7b	159	37.80	3.8	0	4.9	0
8b	158	37.87	3.8	0	10.1	2.8
9b	163	38.18	4.9	1.4	9.4	0
10b	165	38.31	3.5	0	6.6	0
11b	136	38.46	9.7	0	3.8	0
12b	204	38.49	3.1	0	5.9	0
13b	203	38.61	3.1	0	18.1	0
14b	181	38.79	6.9	5.9	14.2	0.3
15b	205	38.96	1.7	0	5.9	0
16b	193	39.04	2.1	3.1	6.6	1.0
17b	132	39.15	5.2	0	6.6	0
18b	131	39.33	2.4	0	5.9	0
Average light pack 2/		37.93	4.3	0.6	8.4	0.2
MEDIUM PACK 3/						
19b	154	39.33	5.2	0	3.5	0
20b	206	39.60	5.2	0.3	9.7	0
21b	209	39.64	4.2	0.3	5.6	0
22b	210	39.71	7.6	0	6.9	0.7
23b	208	39.75	9.0	0	17.4	0
24b	5	39.76	8.3	0	9.9	0
25b	196	39.76	8.7	0	9.0	0
26b	122	39.80	3.8	0	3.1	0
27b	195	39.92	4.2	0	4.9	0
28b	183	39.94	3.8	0	11.5	0

Continued ....

Table 13.--Percentage of head leaf bruising and wrapper leaf bruising by individual shipments from lightest to heaviest and by light, medium, and heavy packs in container 7302, 53 commercial shipments, 1954-55--Continued

Shipment	Code	Net weight	Head leaf bruising		Wrapper leaf bruising	
			Slight to moderate	Serious	Slight to moderate	Serious
No.	No.	Pounds	Percent	Percent	Percent	Percent
29b	211	39.99	3.1	0.3	6.9	0
30b	17	40.05	9.9	1.6	10.2	0.8
31b	182	40.21	1.0	0	11.8	0
32b	149	40.30	11.5	0	2.4	0
33b	185	40.41	0	3.5	9.4	2.4
34b	187	40.59	2.8	0	3.5	0
35b	191	40.83	4.9	0	6.2	0
36b	176	40.84	4.9	0.7	8.3	0
Average medium pack 2/		40.02	5.6	0.4	8.0	0.2
			HEAVY PACK 4/			
37b	186	40.90	2.4	1.0	5.6	0.7
38b	166	40.96	1.7	0	6.6	0
39b	164	41.09	1.7	0	7.6	1.0
40b	194	41.10	6.2	1.0	10.1	0
41b	192	41.19	5.9	3.8	4.9	0
42b	170	41.36	2.1	0.3	5.2	0
43b	175	41.60	4.2	1.0	5.2	0
44b	177	41.61	4.2	0.7	6.6	0.3
45b	179	41.91	5.9	7.3	20.1	2.1
46b	12	42.95	3.6	0	27.3	0.8
47b	19	43.80	13.0	4.2	16.1	4.4
48b	160	44.58	3.1	0	5.2	0
49b	162	44.61	3.5	0	8.3	0
50b	167	45.03	11.5	0	21.5	0
51b	6	45.80	12.0	0	9.4	0
52b	14	47.36	10.7	0.5	14.1	0.5
53b	2	50.08	3.9	0	5.5	0
Average heavy pack 2/		43.29	5.9	1.2	10.9	0.6

See footnotes to table 12.

Table 14.--Percentage of head leaf bruising and wrapper leaf bruising by individual shipments from lightest to heaviest and by light, medium, and heavy packs in container 7303, 62 commercial shipments, 1954-55

Shipment	Code	Net weight	Head leaf bruising		Wrapper leaf bruising	
			Slight to moderate	Serious	Slight to moderate	Serious
No.	No.	Pounds	Percent	Percent	Percent	Percent
			LIGHT PACK 1/			
1c	54	37.47	2.4	0	7.3	0
2c	51	39.40	11.5	6.2	17.7	7.3
3c	95	39.65	10.8	0	7.3	0
4c	30	39.67	2.4	2.8	2.8	0
5c	130	39.74	6.2	0	3.5	0
6c	66	40.35	8.7	0	11.8	0
7c	32	40.45	3.1	0	2.1	1.4
8c	83	40.48	6.6	0	6.9	0
9c	49	40.65	3.1	0	13.5	0.3
10c	52	40.67	6.6	0	15.6	2.1
11c	97	40.70	0	0	10.8	0
12c	94	41.26	2.8	0.3	24.7	2.1
13c	65	41.42	6.2	3.5	7.3	1.7
14c	7	41.47	3.4	0	12.0	0
15c	67	41.56	5.2	2.1	10.4	2.4
16c	61	41.94	6.6	1.4	8.3	1.0
17c	50	42.02	5.2	0	11.5	0
18c	207	42.02	3.8	0	5.6	0
19c	39	42.07	3.5	6.6	6.2	5.2
20c	8	42.32	11.2	0.5	10.4	0.3
21c	25	42.45	3.5	0.7	7.3	0
Average light pack 2/		40.35	5.4	1.1	9.7	1.1
			MEDIUM PACK 3/			
22c	63	42.62	10.1	3.5	10.4	2.8
23c	64	42.66	6.6	0	5.6	0
24c	81	42.87	19.4	7.3	43.1	8.7
25c	98	42.88	1.4	1.4	14.6	0
26c	38	42.91	4.2	1.7	6.9	2.1
27c	15	43.00	7.8	1.6	10.9	2.6
28c	60	43.18	5.2	0.7	8.7	0.3
29c	77	43.41	11.1	0	11.8	0

Continued ......

Table 14.--Percentage of head leaf bruising and wrapper leaf bruising by individual shipments from lightest to heaviest and by light, medium, and heavy packs in container 7303, 62 commercial shipments, 1954-55--Continued

Shipment	Code	Net weight	Head leaf bruising		Wrapper leaf bruising	
			Slight to moderate	Serious	Slight to moderate	Serious
No.	No.	Pounds	Percent	Percent	Percent	Percent
30c	58	43.46	6.2	2.4	7.3	0.7
31c	9	43.52	12.2	0	9.4	0
32c	96	43.63	18.8	0	9.7	0
33c	92	43.74	1.7	0	20.5	2.4
34c	56	43.87	3.8	0.7	5.2	0
35c	48	43.99	9.0	5.2	8.7	5.2
36c	53	44.03	6.2	0.3	9.7	1.0
37c	72	44.11	14.2	0.3	10.1	0
38c	80	44.16	13.9	4.5	31.2	9.7
39c	13	44.21	12.8	0	11.7	0
40c	101	44.21	15.3	0	7.6	0
41c	55	44.26	5.2	0	5.6	0
42c	91	44.40	15.3	0	11.5	0
Average medium pack 2/		43.58	9.6	1.4	12.2	1.7
HEAVY PACK 4/						
43c	74	44.77	14.6	0.3	15.3	2.8
44c	22	45.04	5.5	0	7.6	0
45c	24	45.12	1.0	0	9.4	0
46c	59	45.14	4.9	0.7	13.9	0
47c	78	45.24	16.0	0.7	11.8	0
48c	86	45.36	12.5	3.1	17.7	5.9
49c	73	45.37	1.0	0	9.0	0
50c	69	45.39	3.8	0	29.5	0.3
51c	85	45.60	11.1	7.6	18.1	12.2
52c	93	45.60	2.8	0	15.6	1.4
53c	40	45.69	6.9	0	8.7	0
54c	57	45.97	4.5	0	5.9	0
55c	75	46.29	7.6	1.7	13.5	2.1
56c	102	46.63	2.1	0	9.0	0
57c	103	46.75	0	0	6.2	0
58c	71	47.01	8.3	0.7	12.5	1.7
59c	82	47.33	9.0	1.7	18.8	3.1
60c	68	47.96	11.8	12.2	12.2	9.4
61c	76	48.20	8.7	2.1	21.2	1.7
62c	11	49.55	2.3	0	4.9	0
Average heavy pack 2/		46.20	6.6	1.5	12.9	2.0

See footnotes to table 12.

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